METHODS OF
ASSESSMENT OF AVOIDABLE
BLINDNESS

WORLD HEALTH ORGANIZATION
GENEVA
1980
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>1</td>
</tr>
<tr>
<td>I. SURVEY METHODS</td>
<td></td>
</tr>
<tr>
<td>Preliminary assessment</td>
<td>2</td>
</tr>
<tr>
<td>Population-based sample survey</td>
<td>3</td>
</tr>
<tr>
<td>Preliminary considerations</td>
<td>3</td>
</tr>
<tr>
<td>Preliminary assessment of factors and resources influencing survey design</td>
<td>4</td>
</tr>
<tr>
<td>Sample design</td>
<td>5</td>
</tr>
<tr>
<td>Guidelines for conducting surveys in the field</td>
<td>10</td>
</tr>
<tr>
<td>Sample size considerations</td>
<td>11</td>
</tr>
<tr>
<td>Non-sampling errors and quality control</td>
<td>12</td>
</tr>
<tr>
<td>Administrative and financial aspects</td>
<td>14</td>
</tr>
<tr>
<td>Data recording and analysis</td>
<td>17</td>
</tr>
<tr>
<td>Preparation of data forms</td>
<td>17</td>
</tr>
<tr>
<td>Data analysis</td>
<td>18</td>
</tr>
<tr>
<td>Special considerations for surveys on blindness</td>
<td>21</td>
</tr>
<tr>
<td>II. METHODS OF EXAMINATION</td>
<td></td>
</tr>
<tr>
<td>Screening procedures</td>
<td>24</td>
</tr>
<tr>
<td>Visual-acuity testing</td>
<td>24</td>
</tr>
<tr>
<td>Visual-field testing</td>
<td>26</td>
</tr>
<tr>
<td>Examination of the eye</td>
<td>27</td>
</tr>
<tr>
<td>Primary examination of the eye</td>
<td>27</td>
</tr>
<tr>
<td>Special examinations</td>
<td>28</td>
</tr>
<tr>
<td>Annex 1. Aspects of sampling theory</td>
<td>30</td>
</tr>
<tr>
<td>Annex 2. Signs to be recorded separately for each eye in surveys of blindness</td>
<td>35</td>
</tr>
<tr>
<td>Annex 3. Participants in the San Francisco meeting</td>
<td>41</td>
</tr>
</tbody>
</table>
PREFACE

The goal of the WHO Programme for the Prevention of Blindness is to reduce blindness rates to below 0.5% among overall national populations and to 1% or less among the worst affected communities. The recent WHO publication Guidelines for Programmes for the Prevention of Blindness (Geneva, 1979) stresses the importance of identifying communities in which avoidable blindness is prevalent, as well as the origins and extent of such blindness.

In pursuit of this aim, the Organization convened a meeting of a task force in San Francisco, CA, USA, in December 1979 to prepare the present guidelines on methods for assessing the magnitude and nature of avoidable blindness, particularly in areas of the world in which the major causes of curable and preventable blindness (trachoma, xerophthalmia, onchocerciasis and untreated cataracts) may be prevalent, and in which the relevant statistical data are unlikely to be reliable. The meeting was jointly sponsored by the Organization and by the WHO Collaborating Centre for the Prevention of Blindness and Trachoma, San Francisco.

This guide presents basic principles pertinent to the design, conduct and interpretation of blindness prevalence surveys, the results of which can be used in designing blindness prevention programmes. Some major causes of blindness (e.g., cataract) are found worldwide, while others (trachoma, xerophthalmia, and onchocerciasis) have a more limited distribution. Experience has shown that the health authorities may not be aware that some of these diseases are present until a search is made for them.

It should be stressed that the planning and design of surveys will require the services of a statistician conversant with the special techniques of survey sampling.
I. Survey Methods

Preliminary Assessment

In most areas of the world, information exists from which rough ideas of the magnitude of avoidable blindness can be deduced. This information should be evaluated before a formal survey of the ocular problems in a community is embarked on. Such preliminary assessment also provides data that are valuable for the design of the formal survey. The possible sources of knowledge of this kind are summarized below.

1. Hospital, clinic and eye camp records. Recourse should first be had to data from ophthalmic institutions. Other establishments, such as paediatric hospitals, can yield useful information (e.g., on xerophthalmia among children). Hospital statistics, covering both inpatients and outpatients, may identify seasonal, geographical and ethnic distributions of the common blinding and non-blinding ocular diseases, although the potential biases of such data should be clearly recognized.

2. Schools and institutions for the blind, and blindness registers. These can provide data on the relative importance of different causes of blindness and their relation to age and sex.

3. Health and social insurance records. A review of records relating to the recipients of disability insurance, payments or services will provide information similar to that mentioned in paragraph (2), especially with regard to ocular injuries.

4. Anecdotal information. Local physicians, social workers, public health personnel and community leaders are often a valuable source of information on the problem of blindness, as well as on the local resources available for prevention, treatment and rehabilitation.

5. Previous health surveys. Surveys done for other purposes often provide useful information on the general health status and demographic characteristics of the population.
(6) National and regional censuses. Besides eliciting data of general demographic interest, some censuses also inquire about the existence of various disabilities, including blindness.

POPULATION-BASED SAMPLE SURVEY

Preliminary Considerations

Before undertaking any survey, one must decide what data are to be collected and from which population groups they are to be obtained. Sample size requirements depend, in large part, on the expected prevalence of the conditions to be surveyed. For example, visual disability may be a fairly common event (10-20%); blindness according to the WHO definition (categories 3, 4 and 5 of visual impairment listed in Table 1, page 25) is likely to be less common (1-2%); while blindness due to specific causes may be even more rare (0.2-0.4% for cataracts, 0.1% for xerophthalmic scars). The expected prevalence of the least common conditions of interest determines the size of the sample required.

The administrator or epidemiologist should then decide on the smallest population unit for which he will need a reliable estimate. This often comprises the inhabitants of a minor administrative division - the smallest administrative unit commonly used as the basis for the delivery of health services. Within this administrative entity, the administrator will often wish to know prevalence rates specific to particular age, age-sex, or age-ethnic groupings. Moreover, the decision regarding the size of the population unit must be made before the statistician can begin the sample design.

At this stage of planning, some compromises should be anticipated: if precise estimates for many population subgroups are required, then the sample size of each subgroup must be large. Survey costs will rise dramatically with increases in the number of subgroups for which estimates must be provided. In national prevalence surveys, it is probably unrealistic to demand precise estimates below the province level.
Cost, in terms of money and human resources, is an important factor in carrying out surveys. Persons responsible for programmes will want to increase the efficiency of the operation so as to minimize the cost and make the fullest use of manpower. Costs must always be weighed in relation to the quality and quantity of data obtained. The temptation to add more and more detail to the inquiry often imposes a strain on both the field teams and the respondents, with a consequent danger that the quality of the information is impaired. Expenditure on providing intensive training for interviewers to enable them to handle the more complex questionnaires and the cost of complicated enumeration and processing procedures may offset the savings achieved by combining several topics in one survey. In general, the costs increase with the addition of more sampling units or more items to the basic questionnaire or examination.

Preliminary Assessment of Factors and Resources, Influencing Survey Design

The preliminary assessment of prior information on the existence and severity of blinding conditions and blindness may suggest the need for a population-based survey to provide more accurate or valid estimates of prevalence of selected blinding conditions. Information from the preliminary assessment and from other sources (e.g., national prevalence data) may indicate, at least roughly, the level of prevalence of the blinding conditions to be surveyed - e.g., common, rare, very rare. The design of a sample survey must provide for adequate estimation of the least common of these conditions.

A thorough preliminary assessment should be made of factors and resources which may influence or be useful to the design of the survey. Social, cultural, political, and economic traditions and behaviour may affect the identification, location, and accessibility of various groups of persons to be included in the survey - for instance, seasonal employment patterns and ethnic or socioeconomic clustering. The logistics of a survey may be influenced by climate, weather, geography, and topography, in that these factors may govern the choice of season and the length of time in which the work is to be completed and may also introduce variations that require representation in the sample. In addition, transport and communication modes and systems must be evaluated. All
these factors may play a role in disease prevalence; they are frequently useful in the construction of survey strata.

A thorough effort must be made to ascertain whether materials and data from routine administrative activities or from special programmes exist that might be used as they are, or with modification, in the design of the survey. Such elements comprise maps, aerial photographs, census data (including data on employment patterns and living arrangements), public health tabulations, results of systems of registration of segments of the population, and the materials and findings of other groups involved in survey work in the country (demographic and family planning units, social research institutions, disease control programmes, and agricultural development programmes).

The organization and tabulation of available materials provide the tools for constructing sampling frames. However, the correctness of these elements needs to be verified. The importance of such verification is underscored by the fact that the calculation of prevalence estimates normally requires quantitative data of fairly uniform quality pertaining to the entire target population - i.e., that part of the total population which the survey aims to cover (excluding, perhaps, such groups as persons living in institutions). Such data (size measures) are the links that connect units observed in the survey with units that are not sampled; they are essential components of estimation formulae.

The geographical-administrative structure of the country is subdivided into the smallest units for which preliminary demographic information is available or has to be ascertained for the survey. The existence of migratory groups must be recognized, since their adequate representation in the survey will require special attention and techniques.

Sample Design

A general design that can be modified for local conditions is here described. It is typical of sample designs in current use for health and social surveys of settled populations. The
structure of this general design can be summarized as follows:

- Population subgroups (strata) are defined.
- Strata are divided into primary sampling units (PSU).
- Some PSUs in each stratum are selected for the sample.
- The selected PSUs are divided into second-stage sampling units (villages).
- Some villages are selected for the sample.
- In the selected villages, the population is listed according to household.
- Cities are placed in an urban stratum. Some cities are selected for the sample. The selected cities are subdivided into units (clusters), some of which are chosen for the sample; these are listed and their target population is examined.

The general structure is determined by a number of interrelated procedures. Guidelines are given below. It should be emphasized that local conditions and the availability of size-measure data will suggest refinements and modifications.

Choice of primary (first-stage) sampling unit (PSU)

These units should be well-recognized, "natural", administrative-governmental-civil divisions, somewhat similar to "counties" in the USA. In developing countries, such units are typically the lowest tier in the governmental hierarchy for which reliable map boundaries exist. They are usually the smallest unit for which indicators of some sort - census results, registration data, health services information - are available in a more or less uniform fashion.

Urban areas may stand as their own civil divisions, or they may be contained within a civil division that also includes rural territory. In either case, the inhabitants of urban areas should be considered separately from the rural population.
Stratification

The aim of stratification is to define subpopulations that are internally homogeneous with regard to the level of size measures and to factors that may influence the prevalence of conditions under investigation. The problem of estimating prevalence should be borne in mind as the process of stratification proceeds. After the survey data are collected, the information from selected units will be used to form estimates for units that were not selected for the sample. The only links between selected and non-sampled units are size measures and comparability by virtue of stratification. Estimates for non-sampled units are likely to be poor unless those units closely resemble the units selected for the sample.

PSUs should be grouped into strata at the lowest level of administrative subdivision for which prevalence estimates are to be made. That may be at a regional level, embracing a number of provinces or states.

As far as possible, stratification should distinguish between urban and rural zones, major economic regions, ethnic groups, climatic zones (including the influence of altitude), and zones of potentially different prevalences.

Lists of PSUs within strata should be compiled in rank order of the size measures (of total population) of the PSUs. When the range of size measures within a stratum is large, then the stratum should be divided into substrata of PSUs of approximately equal size. To ease the administration of field work and to simplify the tabulation of data, survey strata should not cross major administrative boundaries such as province lines. Especially large, or unusual, or doubtful PSUs should be singled out and treated individually.

The largest cities should be treated as individual strata or as equivalent to PSUs to be selected for the sample. Smaller cities should be grouped within urban strata, using the principle of apparent homogeneity as a guide.
Selection of primary units

A straightforward and widely acceptable method is systematic selection. From an ordered list of all PSUs within the stratum every nth PSU is selected, n depending on the number of PSUs needed. In practice the first unit is selected at random and thereafter every nth unit is taken.

Units selected at this initial phase should be indicated on maps to ensure that there is adequate geographical dispersion and coverage of the stratum. In the event that the initial choice is concentrated and significant areas of the stratum are unrepresented, then a few sampled units may be replaced, using a randomizing device, to achieve improved distribution of selected units.

Selection of villages

The next step in sampling is to prepare the selection of villages within the chosen PSUs (rural zone). (We are considering a situation in which all the target population resides in settlements.) The same principles for PSUs apply to villages within PSUs. The villages should be listed with whatever measure of their size is available, and their location should be verified on maps. Some field work may be anticipated at this stage. The villages should be grouped according to their size measures within given districts and according to geographical features that sort them into "natural" substrata. It is recommended that the selection should be systematic to ensure a range of sizes for the sample. Randomized replacement to achieve geographical dispersion may be done after the initial selection has been mapped.

On the assumption that one team can examine up to 200 persons in one day, it is advisable to combine, for sampling purposes, small neighbouring settlements into "survey villages" whose target population comprises about 150 persons.

Listing

Before the scheduled date of arrival of the eye examination team, it is recommended that a survey listing team should canvass the selected villages. They should list all members
of each household according to place of residence (house number). Prior to this operation, the listing party should make contact with village leaders and take appropriate steps to encourage cooperation with the examination team.

**Subsampling in large villages**

The economics of field work suggest that all inhabitants of selected survey villages of less than 200 persons should be examined. In larger villages, the number examined will be determined by the daily output of the examining team (150-200 examinations). Normally, the teams should limit the duration of their visit to one or, at most, two days.

In larger villages, both listing and examinations can be conducted on a subsampling basis. The village can be divided into road-bounded blocks or sectors, a sample of blocks selected systematically, and the selected blocks listed and examined. Further subsampling of households or individuals can be done from the lists, if necessary.

**Urban sampling**

Selected cities without clear, convenient municipal subdivisions should be divided into geographical areas, with the aim of creating units that are roughly the size of PSUs in the rural zone (a useful rule of thumb is to take 2000 households or 10,000 persons as an average target size). These large units may be treated as strata that contain sampling units (clusters) of about 40 households or 200 persons (a day's work for an examination team). Clusters should be created from city blocks, or portions of blocks, which are bounded by streets, lanes, and other clearly definable cultural and natural features. Size measures for the clusters may be available from a variety of sources: census tabulations, sampling frames for other surveys, housing unit counts from aerial photographs, etc.

Existing administrative divisions, such as wards or sanitation districts, should be used as strata, subdivided into clusters as described above. The selection, listing and examination of clusters should follow the same general approach as in the rural zone.
Guidelines for Conducting Surveys in the Field

The conduct of a survey differs quite considerably according to the terrain, the distribution of the population, the type of transport available, etc. For example, in mountainous areas where no means of land transport exist and the team has to conduct the survey either by aeroplane or helicopter, or by trekking, the cost involved is higher than in areas where there are good surface transport facilities. The survey team should consist of trained personnel, organized by the centre conducting the survey, and should proceed in a planned manner. It is often helpful, though expensive, to have two teams - one forming an advance party and the other the survey team proper. The advance team goes to the selected villages, meets their leaders, and explains the objectives of the survey. It also instructs the people, including teachers and others in positions of authority, on the conduct and schedule of operations. The advance team, in addition, makes arrangements to obtain accommodation and other facilities and to ensure security for the survey team. The impression made by the advance team is critical to the success or failure of the survey.

The personnel usually required for a survey are as follows:

1. The advance team should be composed of persons prepared to undertake public relations and educational work, mapping, household interviewing, clerical tasks, the securing of accommodation etc., and the recruitment of local personnel as needed.

2. The survey team should consist of an ophthalmologist or a trained examiner, one or two assistants for the examinations and screening, an enumerator and tabulator, and a driver. One of these must serve as the team supervisor.

In addition to the examination and interview procedures detailed elsewhere in this guide, the adoption of the following measures will help to ensure the success of the team's operations:

(a) The basic diseases prevalent in the community should be treated or referred.
(b) Examinations should be scheduled for times appropriate to local conditions.

(c) Esteemed members of the community should be consulted, since they are often valuable intermediaries in establishing community relations.

(d) The behaviour of team members should be such that local customs are respected.

(e) Adequate provision should be made beforehand to manage any major or minor illness to which team members might fall victim, including arrangements for the replacement of persons who might have to be evacuated on this account.

Sample Size Considerations

For a population-based survey use is generally made of some form of stratified multistage sampling. In this case estimation of sample size is complex and dependent on the actual sampling plan. The essential information required to decide on sample size consists of: (1) an approximate estimate of the prevalence or incidence of the conditions to be studied (usually a very rough estimate is all that can be provided but it will suffice); (2) the degree of precision desired for the sample estimate; and (3) the sampling designs that are feasible under the prevailing operational conditions.

The sample estimates provide a range (confidence interval) within which the true population value is most probably located. Usually the probability level is 95%. In such a case there is a 5% chance that the true value is outside the range provided by the sample estimate.

Sometimes the object of a sample survey is to test whether the true prevalence (p) is below or above a preassigned low value such as $p_o$.

When making such a comparison using sampling methods one should consider the risk of two types of error: (1) rejecting the hypothesis (e.g., $p < p_o$) when, in fact, it is true, and (2) accepting the hypothesis when, in fact, it is not true. A discussion on the procedures for securing a balance between
these two types of error is included in Annex 1.

**Non-sampling Errors and Quality Control**

Any difference between the estimate derived from sample observations and the actual value for the target population may be termed error. Part of that error is inherent, attributable to the fact that only a portion—indeed, a sample—of the target population is observed, and is usually called sampling error. The remaining difference between the sample estimate and the target-population value—i.e., discrepancies beyond sampling error—may be the result of a variety of faults in the sample survey procedures and is referred to as non-sampling error. In any survey non-sampling errors derive from numerous sources, and their effects are potentially more serious than those of sampling errors. Such sources can be classified into three groups: coverage, observational, and processing.

Coverage errors can primarily be attributed to undercoverage, overcoverage, or non-response. Undercoverage indicates that some of the target population elements are not included within the sampling frame or actual population sampled, while overcoverage indicates that elements have been included in the sample which are not part of the target population. Non-response occurs when observations have not been made on some sample elements because of refusal to respond or unavailability for examination. Observational errors arise at the time of the making and recording of observations; they may be attributed to observer, respondent, or instrument errors, or to some interaction among those sources. Such problems as errors in the respondent's recall of past events, etc., inter- and intraobserver variability, and simple response errors are examples of observational errors. Processing errors are those encountered at the stage of editing, coding, and data entry and analysis. Such errors are usually the result of clerical errors in the processing of observations for analysis but may also occur on account of errors in analysis, in recording results, or in computation.

There are a variety of ways of controlling non-sampling errors in a survey. An important feature of any survey design is the definition of units in the survey. Villages
with clearly specified borders, households, residents of households, and families must be carefully defined so that the survey objectives can be met and valid results obtained in the field. If such definitions are deficient, both under- and overcoverage errors will result, and the staff will encounter difficulties in field operations.

The application of general survey principles in the training and supervision of field and office staff and in quality-control procedures is extremely important in reducing the occurrence of non-sampling errors. For example, training and supervision should include the following features:

(1) development of training and operations manuals for mapping, enumeration, interviewing, coding and data entry;

(2) careful training, preferably in a field setting, of field staff in mapping and enumerating the village, as well as techniques to improve response;

(3) instruction for those collecting observations in the proper administration of the survey instruments;

(4) careful training of office staff in data coding and entry, with classroom exercises to develop skills;

(5) reinterviews or re-examination of a subsample of the villages and/or households by supervisors;

(6) review and checking by the supervisors at the end of each day of the mapping and enumeration and of the completed forms; and

(7) feedback on performance to field and office staff by supervisors.

In addition, certain quality-control procedures may prove useful in helping to diminish non-sampling errors, as follows:

(1) recorded observations should be reviewed each day by those collecting the information to correct inconsistencies and fill in incomplete items;
(2) the office staff should review all materials on receipt and provide the field staff with feedback on their performance;

(3) at least a sample of all coding and data entry should be checked; and

(4) consistency and "wild" code checks by computer analysis will detect additional errors.

Of course, there are other ways of reducing non-sampling errors, and the usefulness of many of them will depend on the cultural, social, and other conditions in the country. In addition, it is not unusual to make some adjustment in analysis to offset problems of non-response. Observations from respondents may be used to fill the gaps created by non-response, or a system of weighting of responses may be devised to counterbalance the effect of non-response. For a subsample of non-response intensive efforts may be devoted to collecting some if not all observations, using the subsample information to adjust for non-response.

Administrative and Financial Aspects

The public health administrator must always balance the benefits of sample surveys against their cost. It is not possible to generalize about the cost of assessing the prevalence of avoidable blindness in different parts of the world. Differences in staff remuneration alone preclude this. However, it is possible to list the basic cost elements in any survey in their relative order of magnitude. Some estimate can be made of essential and non-essential items, flexible and fixed costs, and minimum and maximum expenditures.

The usual survey budgetary elements are (1) personnel, (2) transport, (3) equipment and supplies, (4) education, motivation and training, and (5) tabulation, analysis, data processing, and the preparation of reports.

The personnel required to form the examining team have been listed on page 10. The unit cost per day in the field for such a team can be estimated. The number of days in the field is a direct function of the size and composition of the
sample. In addition, there should be at least one supervisor at the central level to handle teaching, supervision, scheduling, data control, preparation of preliminary reports, etc. A statistician is required for at least 4-6 weeks to design the sample and should be available during the execution of the survey to answer critical sampling questions. He is also essential for the final analysis and preparation of the report.

Provision must be made at the central level for clerical support in tabulating or coding the initial forms, followed by the processing of the coded data either by hand or by machine. The latter usually requires access to computer services. The preparation and encoding of data are usually more costly than the subsequent computer processing.

In most of the developing countries, transport costs will be the second largest item of expenditure. The total number of villages visited and their distances from the central base are the major determinants. In some remote areas, accessory modes of transport, such as boat, aircraft, or animals, must be considered. The local administrator is by far the best prepared to estimate transport costs, and their importance should not be minimized.

Equipment and supplies are needed for the field team, both for the treatment of medical problems encountered in the villages (antibiotics, antimalarials, eye patches, local anaesthetics, analgesics, etc.), and for the registration and recording of data.

If machine processing of data is used, budgetary allowance must be made for the purchase or rental of the necessary equipment. These costs vary greatly according to country, type of equipment, type and completeness of analysis, amount of data collected, and amount of software development required. It should be emphasized that the sorting, tabulation and analysis of the data by machine are not essential. If enough clerical personnel are available, with good supervision and given the requisite amount of time, basic tables can be generated from the raw, coded data. The cost of this staff must, of course, be added to the other personnel costs, which have been mentioned above.
Fortunately, some of the more important elements of the survey—namely, education, motivation, and training—are usually the least costly. On the basis of knowledge available on local beliefs, customs, habits and behaviour related to health, a series of materials should be prepared to educate "target groups", consisting of professional personnel, public health administrators, local village or urban leaders, community and village inhabitants, and local members of teams recruited to carry out the surveys. Each group requires a different approach and skilled educators are usually needed to prepare the appropriate materials. Such persons, though not always termed "health educators", are available in every national health administration, and thus only the costs of materials must be provided for in the budget. An important element of this activity is the preparation of detailed manuals of procedure for each examining team. This requires the collaboration of the statistician, the epidemiologist, the ophthalmologist, the nurse or technical assistant, and someone thoroughly familiar with the best way of transmitting written ideas, directions, and concepts in the culture concerned. Such training manuals can often be used, with minor adaptation, for other health surveys in the same country.

The above-mentioned costs can be classified as fixed or flexible, to assist in the making of administrative decisions related to the balancing of expenditure against the extent of coverage, the degree of complexity of information considered desirable, and the degree of precision of estimates. Inevitably, a series of trade-off decisions has to be made until an appropriate compromise is reached between available resources and the hoped-for results of the survey.

Personnel costs are fixed by the minimum number of team members and supporting central and local personnel. A field team can examine a target number of households per day, which gives a natural unit of work. Expanding or diminishing the sample size will have a direct linear effect on this cost variable. Additional personnel for supervision increases quality control, the accuracy of estimates, and the reliability of data. Increases in personnel to man more teams or to augment data processing will increase the quantity of data or the speed of analysis.
Transport costs are variable, being determined by the number of villages sampled, by the distances involved, and by the modes of transport required. The addition of villages or sample households may produce only negligible increases in transport costs.

Expenditure on equipment, supplies and educational materials is usually fixed but minor in magnitude; it does not therefore weigh heavily in trade-off decisions.

The costs of data processing are relatively small and quite flexible. The complexity of the analysis, speed of tabulation, and accuracy of data presentation are all directly related to them.

A rule of thumb often used in budgeting for surveys is to allot one-sixth of the total sum for the design and preparation of the sample, two-thirds for field execution, and one-sixth for tabulation, analysis, and presentation. The first and last items are relatively independent of sample size. The major cost determinant is field execution, which is in direct relationship to sample size and allocation. The sample size is, as mentioned previously, determined by the prevalence of the health condition sampled, the desired degree of precision of the estimate, and the size of the smallest geographical or demographic unit for which data are required and of the administrative unit for which some general estimates are expected.

DATA RECORDING AND ANALYSIS

Preparation of Data Forms

A carefully designed data form is required for recording examination findings. This form will contain sequentially numbered main items which may include conditional subquestions. The structure of the response to each question should be predetermined by the use of mutually exclusive categories covering all possibilities. Quantitative data may be recorded in original units to permit flexibility in grouping data for analysis.
Items on the data form should be clear and concise, written in the language common to the examining team but also capable of being conveyed in local languages or dialects. Data based on direct observation are preferred to elicited information. Data forms should be designed for minimal coding prior to transfer for mechanical or electronic processing and should be adapted to the total data system. The care with which the data forms are created, in terms of internal logic and consistency, will have a direct bearing on the efficiency, accuracy, and utility of subsequent tabulations and analysis.

Whenever possible, information of a general nature (environmental, cultural, and socioeconomic) should be collected at the group level—i.e., from a representative of the group concerned (village, cluster or household) to avoid putting the same questions to every individual in the group. There should be a standard method for recording such data as size of village, geographical location, altitude, and economic level.

The minimum information to be collected for each household and individual includes the following data: location, individual identification, date of examination, age, sex, examiner identification, and some measure of pertinent social, economic, and environmental data. Where relevant, data on ethnic group and religion should be included.

Data Analysis

Preliminary phases

It is necessary to outline a general plan for description and analysis that conforms to the specific objectives of the survey and takes into account the type of data processing system that will be used. Description involves the problem of estimating totals, rates, and means for the entire population and for certain defined subgroups of the population. An approach to planning analysis is to consider the various cross-tabulations that will be required to meet the objectives of the survey. The drawing up of dummy tables often clarifies the nature and extent of the cross-tabulations that will be required.
Field edit of forms

At the end of each day of field activities, supervisory personnel should examine all forms for completeness and legibility, resolving any problems that arise and performing elementary consistency checks where possible. It may occasionally be desirable to recall an examinee before leaving the area. Simple tabulations of the individuals examined, as well as of the abnormalities encountered, should be made daily by supervisory personnel to assist in maintaining progress and individual performance and in detecting unusual events requiring special attention.

Coding and data transfer for processing

Coding is the transformation of original recorded data into categories and codes suitable for data processing and analysis. If data collection forms are properly designed, much of the need for coding is eliminated. Data forms should be carefully coded, or otherwise prepared for transfer to the data processing system, concurrently with field work. Ideally, coding should be done at the end of each day's field work.

Editing and preliminary analysis

The first task in data handling is editing — that is, searching for and correcting omissions and apparent errors. Editing may be based on listings of the data, but may also involve the production of frequency distributions of the individual items of information or simple cross-tabulations, which are then checked for consistency. In terms of reliability, speed, and repeatability, editing by electronic computer processing is preferable for large data sets.

Data reduction

Household listings and individual examination records should be summarized for each sample cluster. The cluster summaries should include the total number of persons in the cluster population, subtotals of the cluster population by age and sex, the number of persons examined, and the number of persons in each category of visual impairment. The frequency of significant ocular conditions should also be tabulated.
The cluster summaries of these basic items should be prepared and reviewed by the epidemiologist and the statistician before population estimates are calculated. The summaries will both act as a check and suggest priorities for the next phase of analysis.

Calculation of population estimates and report preparation

Estimates of proportions, means, totals, differences, and other statistics for the population and various subclasses and domains should be prepared according to the preliminary analytical objectives. The variability (standard errors) of these estimates should also be calculated, particularly for important items for which confidence limits are desired. These final estimates should be checked against estimates for the total population from other sources.

A useful administrative device for motivating project staff and providing other interested persons with information is an interim progress report. The progress of the survey should be measured by the routine recording of such data as response rates, number of villages visited, number of examinations completed, and the logistic difficulties encountered. These data may be assembled in the form of progress reports and distributed to project staff and others at regular intervals. When field operations are completed, brief reports may be compiled on the progress of data analysis, including, where appropriate, preliminary survey findings.

A final report on the sample survey should then be prepared. It is recommended that the report should include a statement of objectives; a description of the target population and sampling frame; a discussion of sample design and field procedures, including dates and time of implementation; a presentation of analytical procedures and results, stating standard errors where appropriate; a detailing of costs, personnel and other resources; and some evaluation of the fulfillment of survey objectives. The production of such

---

1 Subdivisions of the population for which separate estimates are planned within the sample design (often the smallest administrative division used in the public health organization — see page 3).
documentation at the end of the survey will be facilitated by careful record-keeping during the course of survey operations.

SPECIAL CONSIDERATIONS FOR SURVEYS ON BLINDNESS

A population-based prevalence survey can have multiple goals. In increasing level of complexity and usefulness these could include the following:

(1) To determine the magnitude of existing blindness, the major causes of such blindness, and their geographical distribution. Such data will provide information necessary for deciding which, if any, areas of the country may be in need of active intervention programmes, and of what type.

(2) To determine the prevalence of active, early or mild forms of diseases found to be major causes of blindness. This information will establish whether the excessive blindness prevalence rates encountered are simply residua of disease no longer active in the community, or part of an active, continuing process contributing to an ever-increasing level of blindness. This is particularly true of preventable blindness due to such causes as xerophthalmia, trachoma and onchocerciasis. New cases of cataract are continually arising in all communities, and the backlog of unoperated cases represents a major cause of avoidable blindness. The reasons for this backlog should be sought.

(3) To provide an understanding of the conditions essential to the development of effective intervention programmes. For example, in xerophthalmia control programmes it will be necessary to know about the availability of leafy green vegetables and the use of potentially fortifiable food items. This information could be elicited in a later survey, conducted in areas in which xerophthalmia has been found to exist, but it might prove more efficient to seek it out in the initial survey.
A series of WHO publications describe detailed methods of assessing xerophthalmia, trachoma, and onchocerciasis. Indiscriminate inclusion of all these methods, however, may result in the collection of large amounts of data irrelevant to the problems of the area or country being surveyed. Instead, their use should be reserved for areas in which preliminary assessment suggests that the diseases in question occur. To guard against the possibility that one or more of these problems may be overlooked because their occurrence has not been suspected, it is suggested that they should be approached in the following manner:

**Xerophthalmia:** Because of its low prevalence, all individuals in the sample should be examined for evidence of conjunctival xerosis and Bitot's spots, corneal xerosis, ulcers, and keratomalacia; and the extent and location of these abnormalities should be noted.

**Trachoma:** The upper tarsal conjunctiva of 10% of all individuals over 2 years of age should be examined for evidence of active trachoma.

**Onchocerciasis:** Blindness from onchocerciasis is limited to areas of tropical Africa and Central and South America in which the blackfly vector is present. Outside these areas it would be pointless to carry out screening activities for the detection of onchocerciasis. In marginal areas, in which the vector may be present but data on the causes of blindness are inadequate, examinations should be made for ocular onchocerciasis. The indicators that would stress the need for this action are the finding of an excess of blindness not explained by other causes in the presence of signs

---


commonly associated with ocular onchocerciasis (sclerosing keratitis, chorioretinal atrophy, optic neuritis, and atrophy), especially if associated with itching or atrophic dermatitis or subcutaneous nodules. It must be borne in mind, however, that ocular onchocerciasis can coexist with trachoma, simple cataract, or other blinding diseases, and that onchocerciasis itself is an important cause of blindness due to lesions such as acute iritis, chronic iridocyclitis, complicated cataract, and glaucoma that are not specific to the disease. It is for this reason that the assessment of onchocercal blindness must include appropriate clinical and parasitological methods for identifying *Onchocerca volvulus* in the skin and eye.

As an additional means of ensuring the collection of adequate data in areas in which trachoma or xerophthalmia, or both, have been found but were not previously suspected, a special subset of examinations, described on page 28, should be carried out if specific abnormalities are present.
II. METHODS OF EXAMINATION

SCREENING PROCEDURES

The content of the examination should be determined by the purpose of the survey and by the availability of personnel. All persons included in the survey should have their visual acuity tested and the anterior segment of their eyes examined. This examination may be performed by an ophthalmologist or by other health workers specially trained in the diagnosis of eye disease.

All persons in the sample should have their vision tested to detect those with a visual acuity of less than 0.3. In addition, they should all have an examination of the anterior eye to detect lesions of the following structures: lids, bulbar conjunctiva, cornea, eyeball, and lens.

VISUAL-ACUITY TESTING

This should be carried out with sizes of test letters or figures (optotypes) consistent with the categories of visual impairment proposed by a WHO Study Group on the Prevention of Blindness\(^1\) and included in the International Classification of Diseases\(^2\) (see Table 1). The kind of optotypes used (e.g., Snellen letters, Landolt rings, or tumbling “E”s) should be understood by those in the region in which the testing will be done. For convenience in field surveys a testing distance of 1 metre, using appropriate optotypes, is suggested. A pin-hole device or optical correction should be incorporated in the testing procedure to compensate for refractive errors when indicated.

---


<table>
<thead>
<tr>
<th>Categories of visual impairment</th>
<th>Visual acuity with best correction&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Decimal notation</th>
<th>Snellen notation&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At 6 m</td>
<td>At 1 m</td>
</tr>
<tr>
<td>Low vision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>&lt;0.3</td>
<td>&lt;6/18</td>
<td>&lt;1/3</td>
</tr>
<tr>
<td>2</td>
<td>&lt;0.1</td>
<td>&lt;6/60</td>
<td>&lt;1/10</td>
</tr>
<tr>
<td>3</td>
<td>&lt;0.05</td>
<td>-</td>
<td>&lt;1/20</td>
</tr>
<tr>
<td>Blindness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>&lt;0.02</td>
<td>-</td>
<td>&lt;1/50</td>
</tr>
<tr>
<td>5</td>
<td>No light perception</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Each subject should be assigned to the highest group applicable.

<sup>b</sup> The numerator in the Snellen notation is the distance at which the test is performed.
For visual-acuity testing, the initial testing of each eye is done with the optotype equivalent to 0.3 (Table 1). Individuals with this level of visual acuity are regarded as normal or near normal and are not subjected to a further test of visual acuity. Persons whose visual acuity is less than 0.3 in either eye are then tested with the largest optotype available to ascertain that they understand the test. If this optotype is correctly identified, progressively smaller optotypes are presented to determine the best achievable visual acuity up to 0.3. For persons who do not respond to the largest optotype, it must be determined whether, in fact, they do not see it or whether they do not understand the test. In such cases the ability to count clearly separated, extended fingers against a contrasting background at 3 metres may be regarded as equivalent to a visual acuity of 0.05 (3/60) and, at 1 metre, to a visual acuity of 0.02 (1/60). In visual testing the test object should be adequately illuminated. If the subject is unable to count fingers, the ability to perceive light is tested and recorded.

For adults and children who are unable to cooperate, the ability of the eye to fix on and follow a target confirms the presence of vision but does not determine a category level as described in Table 1. To test for the ability to fix on and follow an object, the individual's attention is drawn to a light source or target of interest, which is held 30 - 50 cm from the face. Each eye is tested separately. Those with normal vision look directly at the target and follow it as it moves. It is occasionally necessary to distinguish wandering eye movement due to lack of attention from eye movement sometimes exhibited by partially sighted children.

VISUAL-FIELD TESTING

In areas in which onchocerciasis is present visual-field testing should be included in the basic eye examination. Routine visual-field testing may also be desirable in other areas. Under field conditions, confrontational testing is the only practical method.
EXAMINATION OF THE EYE

A dependable source of light of adequate intensity should be used to examine the eyelids, bulbar conjunctiva, cornea and lens. The examiner should utilize magnification of some kind, preferably a binocular loupe giving a magnification of at least x2.5. A slit-lamp biomicroscope may be a useful additional means of examination of the anterior part of the eye, if the examiner is familiar with its use and if an appropriate electricity supply is available.

Adults to be examined should sit facing the examiner, who is also seated. Children can stand facing the examiner. Infants and very young children may be positioned so that their head lies face up between the examiner's knees with the child's body held firmly on the knees of another adult who sits facing the examiner. It may be helpful to restrain a baby's arms by wrapping its torso and arms in a cloth, but it is not necessary to hold the legs.

The examiner's hands should be cleaned with an appropriate disinfectant after each individual is examined. The disinfectant should be dried off before the eyes of the next person are examined.

Primary Examination of the Eye

**Lid:** the lids should be examined for the presence of inturned lashes with or without inturning of the lid margin. Notching and other deformities of the lid margin which interfere with the normal gentle closure of the lids should also be noted.

**Bulbar conjunctiva:** the bulbar conjunctiva should be examined for the presence of a distinct dry granular patch of conjunctiva, best seen on oblique illumination.

**Cornea:** the presence of any abnormalities in the cornea should be noted.

**Lens:** cataract (pronounced opacity of the lens) can be detected on direct illumination.
Special Examinations

Additional examinations of the eye should be carried out for persons with visual impairment or with lesions detected in the preliminary examination.

Visual impairment

All individuals with visual impairment in one eye or both eyes should undergo as complete an ocular examination as possible in order to determine the cause of their blindness. Wherever feasible this should include slit-lamp examination, measurement of intraocular pressure and detailed examination of the posterior segment.

Lid deformities

If upper-lid deformities or other evidence of blinding trachoma are found, the tarsal conjunctiva of all individuals in the household concerned should be examined and graded, as described in Field Methods for the Control of Trachoma (op. cit.), and additional data on local environmental factors should be collected.

Active xerophthalmia (conjunctival or corneal)

Information should be sought on the dietary histories of individuals with xerophthalmia, of non-xerophthalmic age- and sex-matched controls residing in the same cluster, and of members of their respective households, as described in Field Guide to the Detection and Control of Xerophthalmia (op. cit.).

Corneal opacity, or atrophy of the eye

Persons with either of these conditions should receive a detailed examination, and information should be obtained on the age at onset and the presence of concurrent illness at the time of onset. The examiner should use all relevant data to diagnose the probable cause of the lesion:

(1) Corneal opacities present at birth, in the absence of purulent discharge, are most likely to be congenital.
(2) Corneal opacities that developed before the age of 2 months, accompanied by purulent discharge, are most probably caused by ophthalmia neonatorum.

(3) Corneal opacities that developed between the age of 2 months and 6 years are presumed to be due to xerophthalmia unless there is a history of concurrent smallpox, purulent ophthalmia, trauma or measles. However, measles may have been the precipitating cause of xerophthalmia.
Annex 1

ASPECTS OF SAMPLING THEORY

Considerations in Hypothesis-Testing

If an estimate of prevalence, \( p \) (the true prevalence in the general population), from a simple random sample of size \( N \) from the target population is compared with a standard \( p_o \) (below which \( p \) becomes relatively unimportant) by a one-sided significance test at level \( \alpha \), then the power of the test depends on \( N \), \( \alpha \), \( p_o \), and \( p \). In this formulation, there are two possible (but unknown) true relationships between \( p \) and \( p_o \), and two possible decisions which can result from the statistical test. Of these four possible truth-decision combinations, two are correct and two are errors. The probabilities of these errors are \( \alpha \) and \( \beta \), and the power of the test is \( 1-\beta \).

<table>
<thead>
<tr>
<th>Decision, based on statistical test</th>
<th>( P &lt; p_o )</th>
<th>( P &gt; p_o )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truth ( p &lt; p_o )</td>
<td>( 1 - \alpha )</td>
<td>( \alpha )</td>
</tr>
<tr>
<td>( p &gt; p_o )</td>
<td>( \beta )</td>
<td>( 1 - \beta )</td>
</tr>
</tbody>
</table>

The selection of values for \( p_o \), \( \alpha \) and \( N \) must be made by those designing the survey. \( p_o \) is the smallest prevalence considered to be necessary (or desirable) to detect - i.e., a prevalence of less than \( p_o \) is of only minor interest. The probability, \( \alpha \), of erroneously deciding that the observed prevalence is greater than the standard, when, in fact, it is less, is typically chosen to be 0.05 or 0.01, to reflect the importance of falsely declaring that a disease has a prevalence of an important magnitude. The value of \( p_o \) and of \( \alpha \) having been selected, then that of \( N \) may be selected to achieve the desired power - that is, the probability of correctly deciding that the true prevalence being estimated is
greater than the standard. Typical desired values of power are 0.75 or 0.90, but power depends on the unknown true prevalence.

For example (using the table below), if the standard prevalence for comparison is 0.01, and \( \alpha = 0.05 \), then the power of this test procedure to detect a true prevalence of 0.015 ranges from 0.43 (\( N=1000 \)) to 0.93 (\( N=5000 \)). The choice of \( N \) will be made on balancing costs against precision, combining scientific and administrative considerations.

**Power of simple random sampling test of \( p \leq p_0 \) versus \( p > p_0 \), as a function of \( p, \alpha, \) and \( N \)**

<table>
<thead>
<tr>
<th>Standard, ( p_0 )</th>
<th>( p )</th>
<th>( \alpha )</th>
<th>( N=1000 )</th>
<th>( N=2000 )</th>
<th>( N=3000 )</th>
<th>( N=4000 )</th>
<th>( N=5000 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.010</td>
<td>0.015</td>
<td>0.05</td>
<td>0.60</td>
<td>0.79</td>
<td>0.87</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td>0.38</td>
<td>0.58</td>
<td>0.72</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.020</td>
<td>0.05</td>
<td>0.97</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td>0.92</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>0.005</td>
<td>0.007</td>
<td>0.05</td>
<td>0.33</td>
<td>0.36</td>
<td>0.45</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td>0.12</td>
<td>0.16</td>
<td>0.25</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.010</td>
<td>0.05</td>
<td>0.85</td>
<td>0.92</td>
<td>0.97</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td>0.62</td>
<td>0.79</td>
<td>0.92</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.015</td>
<td>0.05</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>0.001</td>
<td>0.003</td>
<td>0.05</td>
<td>0.55</td>
<td>0.79</td>
<td>0.85</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td>0.39</td>
<td>0.54</td>
<td>0.76</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.005</td>
<td>0.05</td>
<td>0.93</td>
<td>0.49</td>
<td>0.99</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td>0.87</td>
<td>0.96</td>
<td>0.99</td>
<td>0.99</td>
<td></td>
</tr>
</tbody>
</table>

In other words, the power of the test is the likelihood of detecting a prevalence rate in our sample at least as large as the minimum rate we are interested in \( (p_0) \), when the true prevalence in the general population is \( p \).
Effects of Clustering on Sample Size Determination

Because persons in the same village will tend to resemble one another, some losses in precision for a clustered sample, when compared to a simple random sample of the same size, may be expected. For example, if everyone in a village were identical (i.e., completely homogeneous), examining a cluster would provide no more information than examining a single individual in that village. Such losses are usually expressed in terms of a design effect (deff), which depends on the average number of persons examined per village ($b$) and some measure of the homogeneity among villagers with respect to the characteristic of interest, $\rho$. The design effect can be written as $\text{deff} = 1 + (b - 1) \rho$ and gives the ratio of the variance for the clustered sample to the variance of a simple random sample of the same size. The larger the average cluster size, $b$, the larger is the value of the design effect, deff, and hence the larger the clustered sample variance as compared to a simple random sample variance.

Some examples will perhaps illustrate the nature of the effects of clustering in sample selection. Suppose that the average village size discussed previously is $b = 200$ persons examined and that the amount of homogeneity in villages is small ($\rho = 0.001$), then $\text{deff} = 1 + (199)(0.001) = 1.20$. That is, the clustered variance will be 20% larger than the variance of a simple random sample of the same size. Thus, in order for a clustered sample to achieve the same level of precision as a simple random sample, the clustered sample would have to be 20% larger, or $(1.20)N$. Values for sample

\[ 1 \rho = \text{intracluster correlation coefficient}. \]

Homogeneity in the case of continuous measures such as height may be interpreted as an expression of the scatter around a mean - for example, if there is a high degree of homogeneity all the individuals in the cluster will have almost the same height. In the case of attribute variables (e.g., presence or absence of disease), homogeneity may be interpreted as similarity of the cluster population as regards the epidemiological characteristics associated with the disease.
size derived under simple random sampling assumptions would have to be adjusted by the design effect in such a manner.

The design effect can be quite large for large average village sizes and modest values of \( \rho \), as shown below.

<table>
<thead>
<tr>
<th>( \bar{b} )</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.001</td>
</tr>
<tr>
<td>101</td>
<td>1.01</td>
</tr>
<tr>
<td>201</td>
<td>1.20</td>
</tr>
<tr>
<td>301</td>
<td>1.30</td>
</tr>
</tbody>
</table>

For example, for \( \rho = 0.010 \) (a modest level of intravillage homogeneity) an average of 300 villagers examined results in a clustered variance 4 times larger than a simple random sample variance. Any sample size derived under simple random sampling assumptions would have to be increased fourfold if a cluster of size 300 and homogeneity for some characteristic of 0.10 were anticipated.

Example:

Suppose it is desired to select a sample size large enough to ensure that the survey will identify cataract as a major cause of blindness if the true prevalence of blinding cataract is at least \( p_{0} = 0.005 \). A 1 in 20 chance (\( \alpha = 0.05 \)) of erroneously claiming that prevalence is greater than 0.005, when, in fact, it is not greater, is acceptable. From the table on page 31 it can be seen that a simple random sample size of \( N = 3000 \) is required to be 92% confident of identifying blinding cataract as more prevalent than 0.005, when, in fact, its true prevalence is 0.010. If average cluster size is 300 and blinding cataract is thought to be of very low homogeneity (\( \rho = 0.001 \)) in a cluster, then the simple random sample size is inflated by the design effect factor 1.3, resulting in an adjusted sample size estimate of \( 3000 \times 1.3 = 3900 \). This
sample size is required for every group for which a prevalence estimate is required. If the group concerned is "all preschool-age children," that many children of preschool age need to be examined. If estimates are required for each province, that many individuals need to be examined in each province.
Annex 2

SIGNS TO BE RECORDED SEPARATELY FOR EACH EYE
IN SURVEYS OF BLINDNESS

Visual Testing

<table>
<thead>
<tr>
<th>Code</th>
<th>Visual acuity</th>
<th>Category of visual impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$\geq 0.3$</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>$\geq 0.1$</td>
<td>Category 1</td>
</tr>
<tr>
<td>2</td>
<td>$\geq 0.05$</td>
<td>Category 2</td>
</tr>
<tr>
<td>3</td>
<td>$\geq 0.02$</td>
<td>Category 3</td>
</tr>
<tr>
<td>4</td>
<td>Light perception</td>
<td>Category 4</td>
</tr>
<tr>
<td>5</td>
<td>No light perception</td>
<td>Category 5</td>
</tr>
<tr>
<td>6</td>
<td>Able to fix and follow a target (for those unable to cooperate)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Not able to fix and follow a target</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Not testable or not tested</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Undetermined or unspecified</td>
<td>Category 9</td>
</tr>
</tbody>
</table>

Primary Eye Examination

Indicate presence or absence of the following:

Lids

- Inturned lashes with or without inturned lid margins
- Notching or other deformity preventing gentle closure of lids
Bulbar conjunctiva

Bitot's spot / Xerosis, temporal
Bitot's spot / Xerosis, nasal
Bitot's spot / Xerosis, elsewhere

Cornea and eyeball

A. Specific corneal conditions:

Xerosis
Keratomalacia
Corneal ulcer other than keratomalacia
Pterygium
Sclerosing keratitis (onchocercal type)
Band keratopathy
Phlyctenular disease
Other (specify) .................

B. If corneal scars or atrophy of the eye (phthisis bulbi) are present:

1. History

   (a) Age at onset

       Present at birth
       Birth to under 2 months
       2 months to under 6 years
       6 years to 15 years
       Over 15 years
       Uncertain
(b) Presence or absence of concurrent illnesses or events at time of onset

None
Measles
Swollen legs
Smallpox
Trauma
Furulent ophthalmia
Eye surgery
Other
Uncertain

2. Most likely cause of corneal scars or atrophy of the eye

Congenital
Trachoma
Other infections
Onchocerciasis
Xerophthalmia
Trauma
Other
Not identified

C. Categories of corneal opacities:

1. Corneal opacity involving the visual axis (central opacity)

0 - No opacity of central cornea
1 - Central opacity with the pupillary margin visible through the opacity
2 - Central opacity through which the pupillary margin cannot be seen
2. Opacity of the peripheral cornea
   0 - No peripheral opacity
   1 - Localized peripheral opacity involving less than one half the circumference of the cornea
   2 - Peripheral opacity involving more than one half the circumference of the cornea

Lens status
   0 - No lens opacity
   1 - Cataract, immature
   2 - Cataract, mature
   3 - Aphakia
   4 - After-cataract
   5 - Other
   6 - Not examined

Additional Conditions to be Sought when Examining Persons with Visual Impairment and Other Lesions

Optic Nerve
   Neuritis or swelling
   Optic atrophy
   Glaucomatous cupping
   Other
Retina

Disease of the macula
Chorioretinal scars
Vascular retinopathy
Retinal detachment
Other

Intraocular pressure

If measured, record method and actual scale reading

Checklist of Major Causes of Visual Impairment, if any

Refractive error
Strabismic or refractive amblyopia
Corneal opacity
Cataract
Chorioretinal
Optic atrophy
Glaucoma
  - open angle
  - narrow angle
  - other
Atrophy of the globe - including absence
Other
Unspecified or undetermined
Checklist of Etiologies of Visual Impairment

Developmental
Ophthalmia neonatorum
Trachoma and associated infections
Onchocerciasis
Measles
Smallpox
Other infections
Nutritional
Trauma
Degenerative
Iatrogenic
Other
Unspecified
Annex 3

PARTICIPANTS IN THE SAN FRANCISCO MEETING

Dr A. A. Ahmad, Department of Ophthalmology, Salmaniya Medical Centre, Manama, Bahrain

Dr J. Bond, Pan American Health Organization/WHO Regional Office for the Americas, Washington, DC, USA

Dr F. Contreras, Director, WHO Collaborating Centre for the Prevention of Blindness, Department of Ophthalmology, Santo Toribio de Mogrovejo Hospital, Lima, Peru

Dr C. R. Dawson, Director, WHO Collaborating Centre for the Prevention of Blindness and Trachoma, Francis I. Proctor Foundation for Research in Ophthalmology, University of California, San Francisco, CA, USA

Professor B. R. Jones, Director, WHO Collaborating Centre for Reference and Research on Trachoma and other Chlamydial Infections, Department of Clinical Ophthalmology, Institute of Ophthalmology, University of London, England

Dr K. Konyama, Department of Ophthalmology, Juntendo University School of Medicine, Tokyo, Japan

Professor I. F. Maichouk, Director, WHO Collaborating Centre for the Prevention of Blindness Caused by Infectious Eye Diseases, Department of Viral and Allergic Eye Diseases, Helmholtz Research Institute of Ophthalmology, Moscow, USSR

Dr R. P. Pokhrel, Head, Eye Department, Nepal Eye Hospital and Bir Hospital, Kathmandu, Nepal

Dr A. Ross, Chairman, Department of Biostatistics, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, MD, USA

Dr J. Schachter, Director, WHO Collaborating Centre for Chlamydiaceae, George Williams Hooper Foundation, University of California, San Francisco, CA, USA
Dr A. Sommer, Director, WHO Collaborating Centre for the Prevention of Blindness, International Center for Epidemiologic and Preventive Ophthalmology, The Wilmer Institute, The Johns Hopkins Hospital, Baltimore, MD, USA

Dr M. L. Tarizzo, Programme Manager, Prevention of Blindness, World Health Organization, Geneva, Switzerland

*   *

The participants wish to acknowledge the contributions made by the following persons, who attended the meeting in the capacity of observers: Dr L. Brilliant, University of Michigan, Ann Arbor, MI, USA; Dr A. Colenbrander, Pacific Medical Center, San Francisco, CA, USA; Dr N. Grasset, Douvaine, Haute-Savoie, France; Dr I. Hoshiwara, Phoenix Indian Medical Center, Phoenix, AZ, USA; Dr J. Lepkowski, University of Michigan, Ann Arbor, MI, USA; Dr R. Meaders, International Eye Foundation, Bethesda, MD, USA; Dr R. Milton, National Eye Institute, National Institutes of Health, Bethesda, MD, USA; Dr I. Schwab, Pacific Medical Center, San Francisco, CA, USA; and Dr D. W. Vastine, Pacific Medical Center, San Francisco, CA, USA.